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Nickel-Base Superalloy's Excellent Properties Promote Its Service to 2200° F

A nickel base alloy with high strength, ductility, good impact and oxidation resistance, microstructural stability, workability potential, and the ability to show improved strength and ductility when directionally solidified has recently been developed for high temperature applications. The nominal composition of this alloy, designated TAZ-8B, in weight percent is 8 tantalum, 6 chromium, 6 aluminum, 4 molybdenum, 4 tungsten, 1.5 columbium, 5 cobalt, 1 zirconium, 0.125 carbon, 0.004 boron and the balance nickel. The alloy achieves high temperature strength by a combination of mechanisms: (1) the Ni_3Al intermetallic phase is formed; and (2) solid solution strengthening occurs due to the presence of some of the heavier elements such as Ta, W, and Mo, and stable carbides such as TaC are formed.

Earlier work at the NASA Lewis Research Center has resulted in the TAZ-8 alloy series (see NASA Tech Briefs 66-10222 and 68-10094). The alloys in this series all have good high temperature strength and, although basically cast materials, have considerable workability. TAZ-8A, the immediate predecessor of the subject alloy, also has oxidation resistance comparable to the most oxidation-resistant nickel base alloys presently available. The high temperature capability of TAZ-8B has been achieved by modifying the composition of TAZ-8A with the addition of cobalt so that the gamma prime strengthening phase remains stable to higher temperatures, and by reducing columbium content to increase ductility.

By applying controlled solidification techniques in casting the alloy, a directionally-oriented grain structure can be achieved. For this alloy, directional

solidification provides a further increase in high temperature strength and intermediate temperature ductility, since intergranular failures along grain boundaries transverse to the loading axis are effectively eliminated. In the directionally solidified form, TAZ-8B has an ultimate tensile strength of approximately 180,000 psi at 1400° F. and an elongation of about 6 percent at 1400° F., which is the minimum ductility point for this alloy.

Upon the basis of metallographic examination and calculated average electron vacancy number, the alloy does not appear to be subject to embrittlement by sigma phase formation, a problem with many other high strength nickel-base alloys.

Notes:

1. TAZ-8B alloy combines (1) high temperature strength comparable to the strongest commercially available cast alloys, (2) demonstrated workability potential which allows the alloy to be rolled from cast slabs to sheet form, (3) high-impact and thermal-shock resistance, (4) excellent oxidation resistance, and (5) long-time microstructural stability. In addition, the alloy lends itself to directional solidification techniques which provide significant improvements in intermediate and high temperature ductility as well as stress rupture life over a wide range of temperatures, and 100 percent increases in notch bar impact resistance.
2. Further information concerning this innovation is presented in NASA Technical Note D-4390, "Application of Directional Solidification to a NASA Nickel-Base Alloy (TAZ-8B)," by John C. Freche, William J. Waters, and Richard L.

(continued overleaf)

Ashbrook, February 1968, available from the Clearinghouse for Federal Scientific and Technical Information, Springfield, Virginia 22151; price: \$3. (Microfiche \$0.65). Inquiries may also be directed to:

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Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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